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1. INTRODUCTION

ESA MCB 51 is a development board and supports a wide variety of 8051 (with on-chip ROM) compatible 8-bit micro controllers. The 8051 family of micro controllers are extensively used for embedded and real-time applications. **ESA MCB 51** is designed to be a general-purpose development board for Single Chip MCU applications that may be used as an instructional learning aid and also as a development tool in R&D labs in industries.

ESA MCB 51 development board is built around **Atmel AT89C51ED2** / **RD2** micro controller that has 64Kbytes of on-chip program memory.

1.1 ESA MCB 51 CAPABILITIES

- The power full on-chip flash monitor provides communication with Keil µ Vision Debugger.
- Executes the User Programs at full speed or Debug the Program using Single Step and Break Point facilities available in Keil µ Vision Debugger.
- Examine/Modify the contents of CPU registers and memory contents.
- On-Board LCD (16x2), interfaced to port lines.
- All the 32 I/O (Port) lines are terminated on 4 different 10-pin connectors.
- 24 port lines (i.e. P0, P1 and P2) are terminated on a 26-pin connector.
- All the CPU Signals are terminated on a 40-pin connector for system expansion.
- On-Board ISP support for On-Chip flash programming.

The **ESA MCB 51** kit includes the following items

- **ESA MCB 51** Board
- **ESA MCB 51** User Manual (this manual)
- RS-232 C Cable
- A CD-ROM containing
    I. Keil Evaluation version.
    II. Sample Programs for ESA Interface Modules.
    III. **ESA MCB 51** Monitor Hex file.
    IV. Atmel's FLIP flash programming utility.
    V. **AT89C51ED2** /**RD2** Data Sheet.
- 8051 Instruction set reference Card.

1.2 SPECIFICATIONS

PROCESSOR

- AT 89C51ED2 / RD2 operating at 11.0592 MHz

PROCESSOR FEATURES

ON-CHIP MEMORY

CODE MEMORY: 64K Bytes of flash.

DATA MEMORY: 256 Bytes of RAM.
1792 Bytes of XRAM.
2K Bytes of EEPROM.

ON-CHIP PERIPHERALS

- 3 16-bit Timers/Counters.
- Watch Dog Timer.
- Programmable Counter Array (PCA) on Port1 i.e. PWM and Capture & Compare.
- SPI (Serial Peripheral Interface) on Port1.
- Full duplex enhanced UART.

INTERRUPTS

Nine sources of interrupt (both external and internal).

Two External interrupts INT0 and INT1 are provided with push button switches; these can also be used as general-purpose switches.

INTERFACE SIGNALS

CPU:

All the CPU signals available on a 40-pin connector site.

I/O (Port) Lines:

P0, P1 and P2 Port lines are available on a 26-pin connector,
compatible to ESA Interface Modules.
Four 10-pin connectors for all the 32 I/O lines.

LCD:

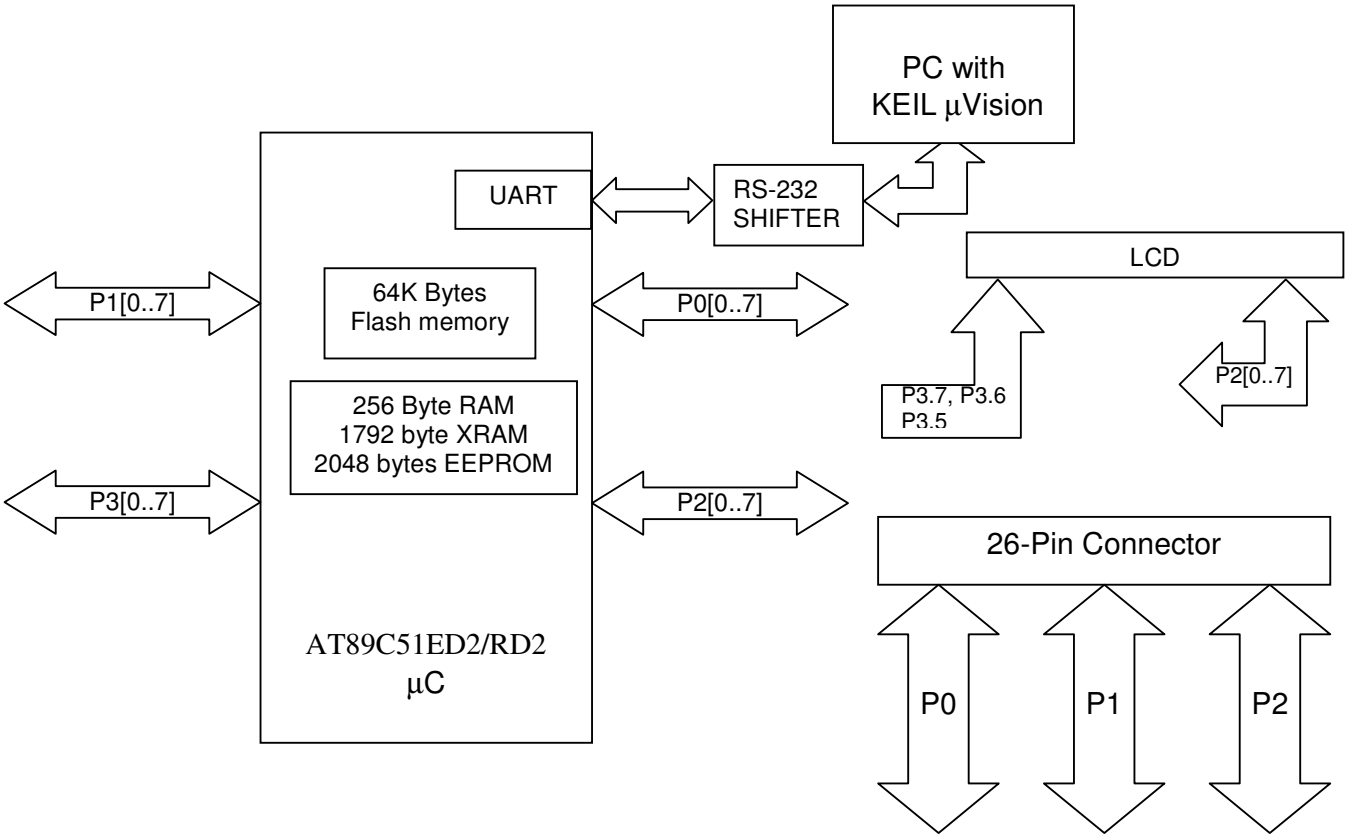
LCD compatible signals are available on a 16 Pin flow strip connector.

SERIAL I/O:

On-Chip UART signals are available through MAX 232 on a RJ-11 connector.

1.3 GENERAL DESCRIPTION

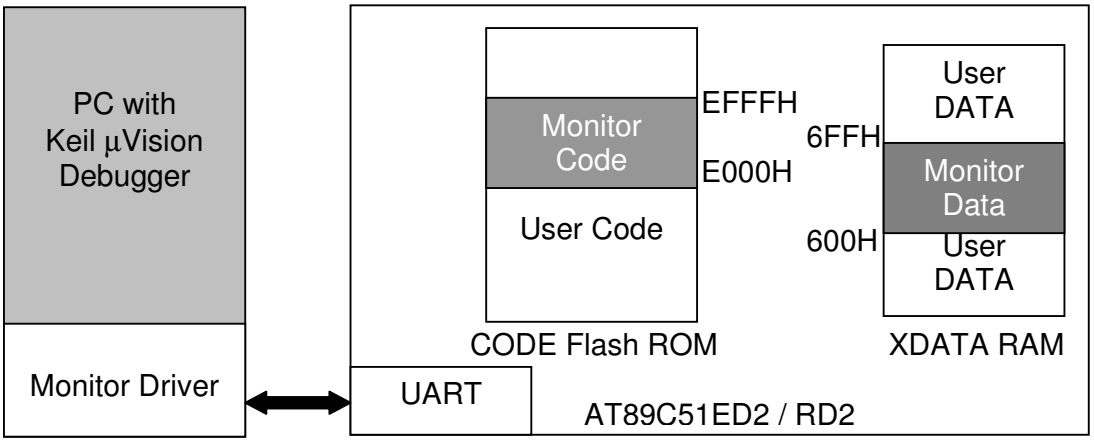
1.3.1 BLOCK DIAGRAM



The ESA MCB 51 is built around AT89C51ED2/RD2; this board provides a platform to user to evaluate the on-chip features of 8051 family microcontrollers. Please refer the datasheet of AT89C51ED2/RD2 for more details of the chip. The 32 I/O lines of the microcontroller are available to user on different connectors (Please refer Hardware chapter for more details on these connectors). A 16x2 LCD, which is interfaced to 11 port lines, is available to user. The on-chip UART is used to interface the board with PC.

The trainer uses the on-chip flash monitor to communicate with Keil µVision Debugger. The Flash monitor allows the user to program and debug the on-chip code. The monitor uses the on-chip UART to communicate with µVision Debugger.

Typical layout of the flash monitor and Keil debugger is as follows.



2. CONFIGURATION AND INSTALLATION

This chapter describes about configuration and the installation procedures of ESA MCB 51. The ESA MCB 51 board requires +5V power and a serial connection to a PC running Keil µVision debugger.

Hardware Requirements

- The **ESA MCB 51** Board.
- A serial cable, given by the manufacturer i.e.RJ11 to 9-Pin female cable.
- A PC (450Mhz and above) with an available RS-232 Port, 128 MB RAM and 30MB Hard Disk Space.

Software Requirements

- Microsoft Windows 98/ME/NT/XP/2000
- The Keil µ Vision IDE and Debugger. The flash monitor is already programmed in the on-chip flash of AT89C51ED2 / RD2

2.1 CONFIGURATION

The Board will be shipped with ready configuration to connect with Keil IDE. Make sure that the switch SW1 is kept in the **Exec Mode** before connecting.

2.2 INSTALLATION

1. Connect +5V@1A power supply to the board.
2. Connect the serial cable, 9-Pin Female connector to PC and RJ11 connector to **ESA MCB 51**.
3. Switch ON the power to board; the following Sign On message should be displayed on the LCD.

```
ESA MCB 51 VX.YY   here x-indicates version
                              Y-indicates revision
```

If no message is displayed on the LCD, then check the power supply connections and the switch SW1 as described in the earlier section. If the problem still persists, please contact the manufacturer.

After the Power up, the board can be connected to Keil IDE to download and execute the user programs. The **Keil Monitor-51 Driver** is used to download the

user application code into on-chip flash, and also to debug the downloaded user application code.

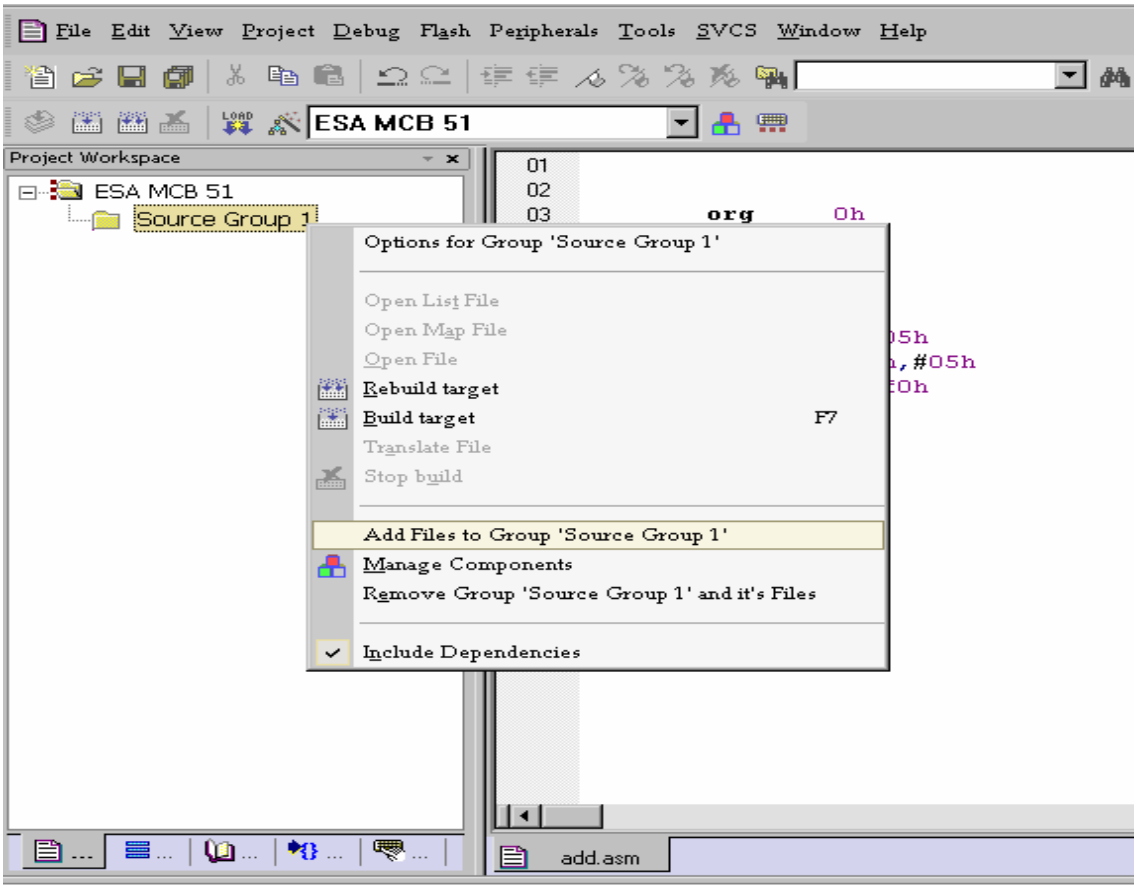
2.3 INTEGRATION WITH KEIL

The following steps describe the user, how to create and compile µ Vision2 project for **ESA MCB 51** board. User can find more information on Keil project creation and compilation in the ***µ Vision2 and C51 Getting Stated User's Guide.***

1.

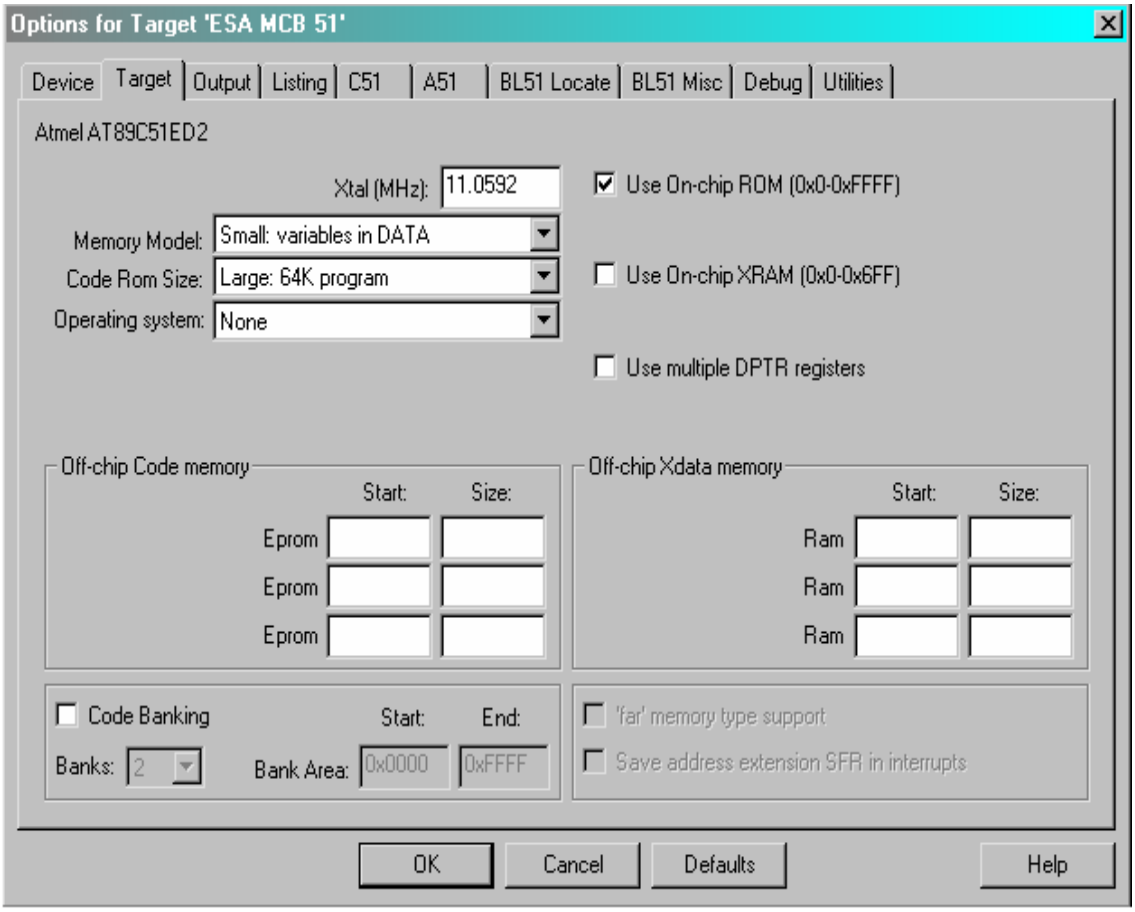
(Or)

Start the µ Vision2 or µ Vision3 IDE, create a project file with **Project – New Project,** and select the CPU from the device database. Select AT89C51ED2 or AT89C51RD2 as per the board.
2. Create and save a source file and add this source file to the project. This can be done in the dialog **Project – Target, Groups, Files…**or with a right click on the Source Group in the Project Window and the **Add Files to Group** option.

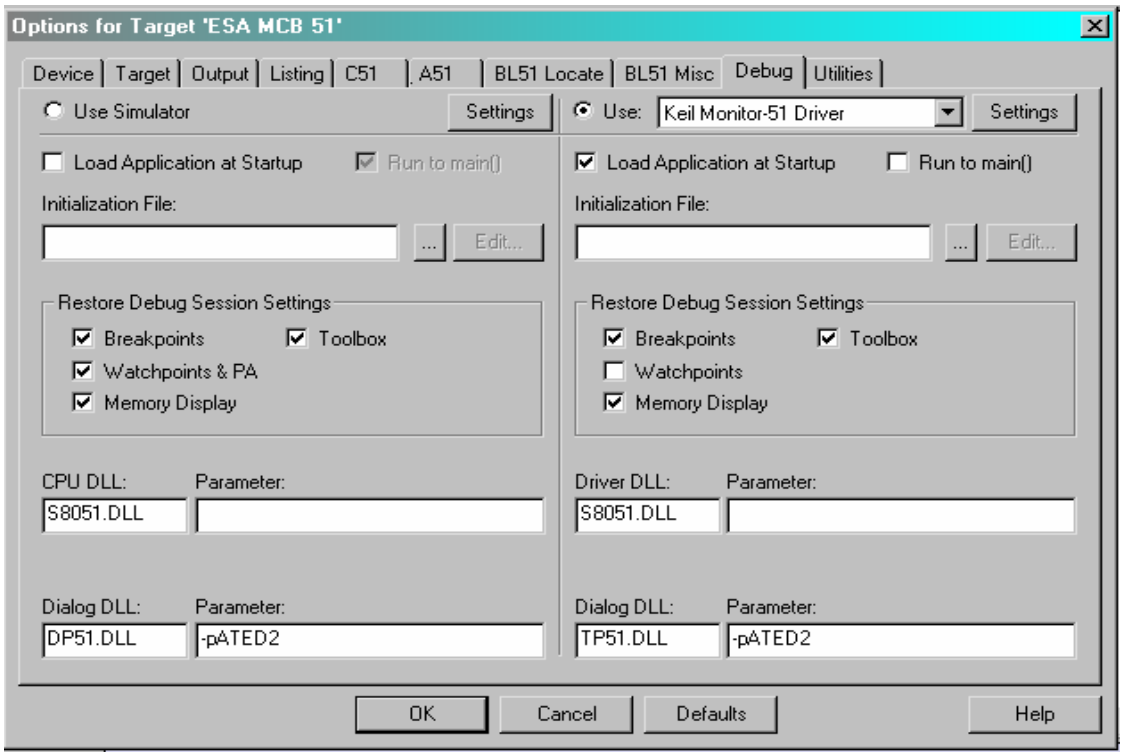


3. Set the Target options for the **ESA MCB 51** as shown below**.**

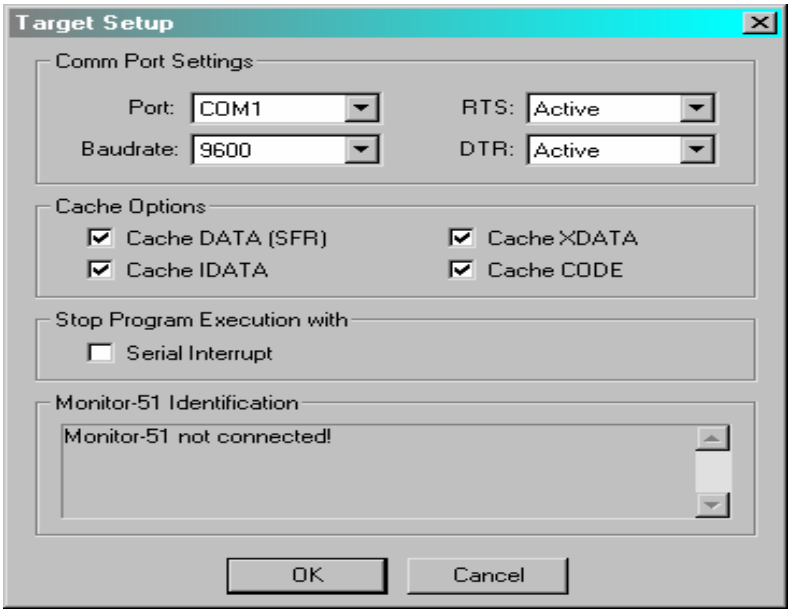
   Project – **Options for Target** opens the µ Vision2 **Options for Target – Target** configuration dialog. Set the Xtal frequency as 11.0592 Mhz, as per **ESA MCB 51.**



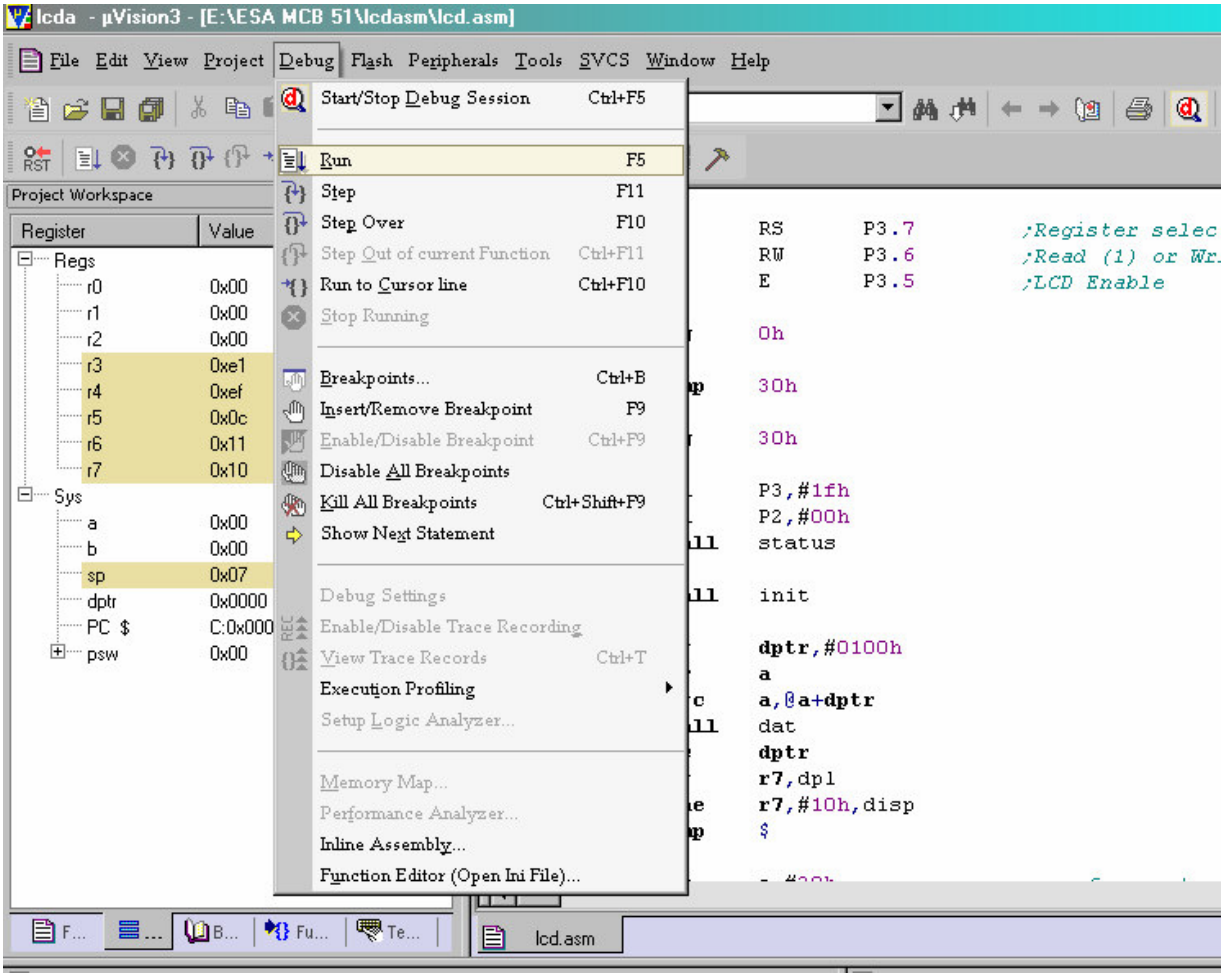
4. Since the **ESA MCB 51** Monitor uses the code memory area from 0x0E000 to 0x0EFFF, the user application source need to use memory from 0x0000 to 0x0DFFF. Compile the written source and set the required **debug** options as shown below.



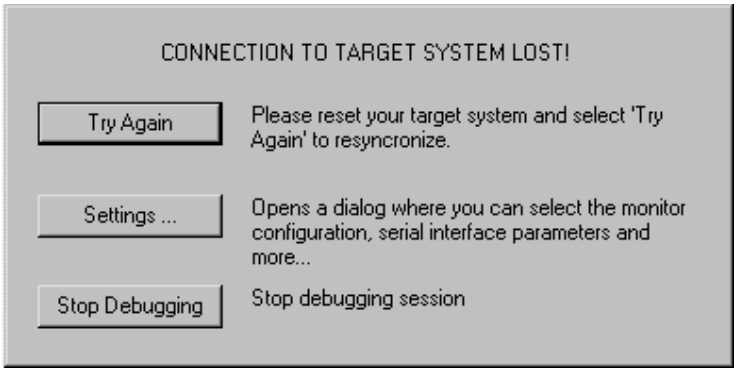
5. Select **Use Keil Monitor-51 Driver** in the **Options for Target – Debug** page. To load and start user application, enable **Load Application at Startup** option.
6. Select appropriate communication settings using the **Settings** button in the Debug page as shown below.



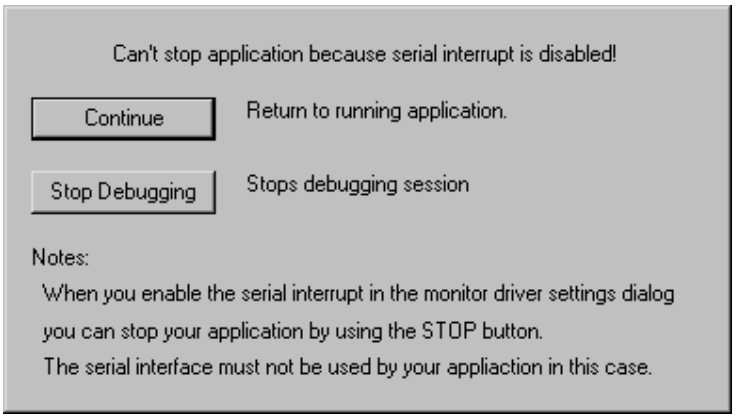
7. Under the COM Port settings select the COM Port to which the board is connected and select the baud rate as 19200 or 9600 (recommended). Enable **Serial Interrupt** option if the user application is not using on-chip UART, to stop program execution.
8. Build the project; µ Vision translates all the user application and links.
9. After the Build, press Reset on **ESA MCB 51.**
10. Now user can enter into **Debug** mode with **Debug- Stat / Stop Debug session** dialog.
11. The debugger connects to **ESA MCB 51** and downloads the user application program into flash memory and also the debugger enables all the debugging features like **Run**, **Step**, **Step Over** etc.,



12. In Case of any Communication problems a dialog box opens that displays further options and instructions as shown below.


CONNECTION TO TARGET SYSTEM LOST!
Try Again
Please reset your target system and select 'Try Again' to resyncronize.
Settings ...
Opens a dialog where you can select the monitor configuration, serial interface parameters and more...
Stop Debugging
Stop debugging session

13. Here check for correct COM Port settings and ensure the COM Port working condition. Check the monitor configuration whether **Keil Monitor-51 Driver** is selected or not. Press Reset on **ESA MCB 51** and Try again. If the problem still persists, please contact the manufacturer.
14. To stop the execution of user application programs, use **Stop** option in **Debug** dialog. If the user enabled the **Serial Interrupt** in **Target – Debug** settings then the program execution stops normally, otherwise it displays a sub window as shown below.


Can't stop application because serial interrupt is disabled!
Continue
Return to running application.
Stop Debugging
Stops debugging session
Notes:
When you enable the serial interrupt in the monitor driver settings dialog
you can stop your application by using the STOP button.
The serial interface must not be used by your appliaction in this case.

15. Here user can use the **Stop Debugging** button to stop the application program execution.

3. ESA MCB 51 HARWARE DESIGN DETAILS

This chapter describes the following hardware design details of **ESA MCB 51**:

- CPU
- On-Chip Memory Map.
- Ports.
- Serial Interface.
- LCD Interface.
- Interrupts.
- Connector Details.

Note: Please refer AT89C51ED2 / RD2 Data Sheet for more details about the features of microcontroller.

3.1 CPU

ESA MCB 51 can be operated with **AT89C51ED2 or AT89C51RD2** micro controller.

The board will be shipped with either of the above-mentioned CPU.

3.1.1 CPU RESET

The board comprises of power on reset circuit, the switch named as **RESET** switch can be used to reset the microcontroller.

3.1.2 CPU CLOCK

An 11.0592 Mhz crystal is connected between the oscillator pins of the microcontroller. The CPU uses this as clock source.

3.1.3 CPU BUS

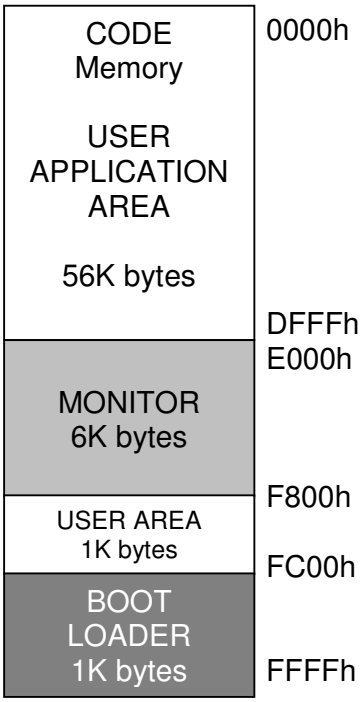
All the CPU signals are terminated on a 40-Pin connector site **J8**. User can make use of this connector for system expansion.

3.2 ON-CHIP MEMORY MAP

3.2.1 CODE or PROGRAM MEMORY

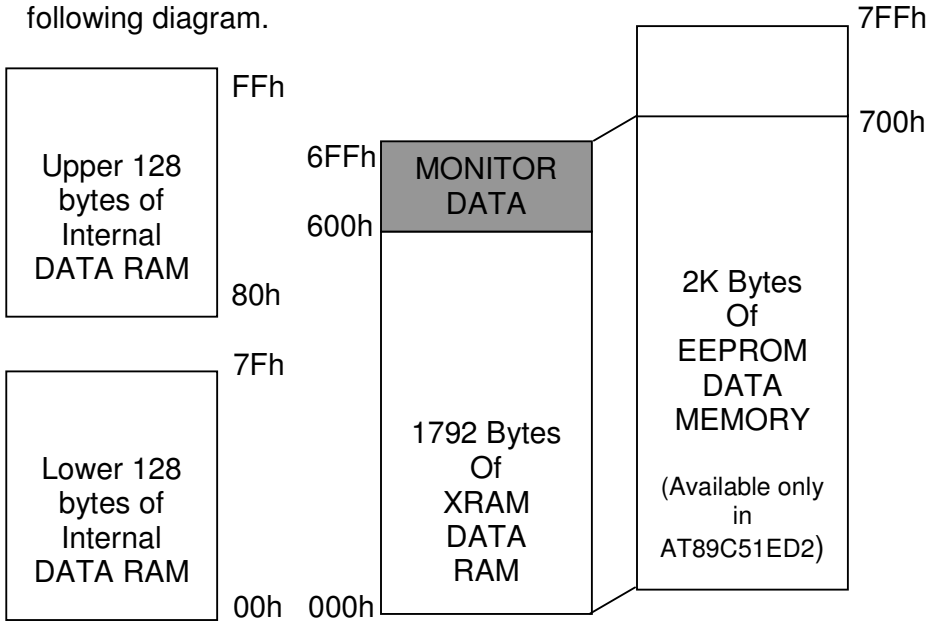
The **AT89C51ED2** / **RD2** provides on-chip flash program memory of 64Kbytes, ranges from **0000h** to FFFFh. The **EA*** signal of the MCU is hard wired to Vcc, so that the Processor fetches the code from on-chip memory. The **ESA MCB 51** uses 6K bytes of on-chip flash for monitor program, the monitor program ranges from **E000h** to **F800h**. The **Boot Loader** (provided by Chip Vendor) for **ISP** (In-System Programming)

occupies 1K bytes of flash memory from **FC00h** to **FFFFh**. User has to make sure that the user application program should not use the **Monitor** and **Boot Loader** memory ranges. The diagram given below shows the Code or Program memory layout of ESA MCB 51.



3.2.2 DATA MEMORY

The on-chip data memory of AT89C51ED2 / RD2 is as shown in the following diagram.



The on-chip data memory includes 256 bytes of RAM as internal data memory, 1792 bytes of RAM as external data memory and 2K bytes of EEPROM as external data memory. Of these **ESA MCB 51** monitor uses 256 bytes of XRAM for monitor data. So, User has to make sure that the monitor data area should not be disturbed.

3.3 PORTS

All the 4 Ports of the microcontroller are available on different connectors for different interfacing options. The connector details are as follows.

1) 4 Ports on 4 different 10-Pin connectors.

PORT	CONNECTOR
P0	J1
P1	J2
P2	J3
P3	J4

2) The Ports P0, P1 and P2 are on 26-Pin connector **J7.**

User can make use of the above connectors for different interfacings and also care has to be taken while interfacing the same port lines on the different connectors.

3) 3 lines from P3 (i.e. P3.7, P3.6, P3.5) and 8 lines from P2 are used to interface the on-board LCD.
4) On-chip UART lines i.e. P3.0 and P3.1 are used for serial interface.

IMPORTANT NOTE: Since the same the Port lines are available in different connectors for different interfacing options, the user should take care about using the same port lines on different connectors i.e. the port lines that are under use in one connector should not be used in other connectors. However in some exceptional cases this can be done without any conflict.

3.4 SERIAL INTERFACE

The on-chip UART is used for serial interface with the PC; these signals are level shifted using MAX232 for RS-232C compatibility. The RS-232C signals are available on RJ11 connector **J6**.

The ESA MCB 51 monitor uses the on-chip UART to communicate with the Keil µ Vision debugger.

3.5 LCD INTERFACE

A 16x2 LCD is interfaced to the port lines of MCU. User application programs can make use o this LCD as a console.

3.5.1 Description of the LCD Module

These modules come in variety of formats like 8x1(eight characters per line and one line), 8x2(eight characters per line and two lines), 16x1(sixteen characters per line and one line), **16x2**(sixteen characters per line and two lines), 20x2(twenty characters per line and two lines), 20x4 (twenty characters per line and four lines) etc.

LCD accepts characters in ASCII format. Character display font in LCD module is by matrix of dots i.e. each character in LCD module can be represented by 7x5 matrix (7 rows and 5 columns of dots) or 10x5 matrix (10 rows and 5 columns of dots). This interface is built over **16x2** LCD module in which the display data RAM address of LCD module for the first line starts from 00H to 14H and the second line starts from 29H to 3CH. The following table shows the interfacing details of the LCD.

3.5.2 LCD Pin Description and Interface to MCU

PIN	SYMBOL	FUNCTION	PORT on MCU
1	Vss	Ground	
2	Vcc	+5v supply	
3	Vo	LCD contrast control	
4	RS	Register Select RS=0 Instruction register RS=1 Data Register	P3.7
5	R/W*	Read/Write 1=Read 0=Write	P3.6
6	E	Enable	P3.5
7 to 14	DB0 to DB7	Bi-directional data bus	P2.0 to P2.7
15	L+	Back light power of +5V	Hard wired to Vcc

LCD module has an automatic reset, which is critically dependent upon power supply voltage. Voltage has to rise from 0.2v to 5v within 10 to 15ms for the LCD to reset. Since this is not accurate we choose to give some delay in the application program while initializing it. The Busy Flag of the LCD module will be set while LCD is resetting and also when data or command has been written. At this time user cannot write on to the LCD module. Data can be written on to the module only when busy flag goes low.

3.5.3 Initialization of LCD Module

LCD module has to be initialized before writing any program on to it. Initializing includes choosing character font, initializing cursor for blinking and auto increment etc. User has to choose the appropriate instruction code from the instruction set and send it over the module. The control signals viz RS, R/W*and E signals has to be selected using the corresponding Port bits i.e. P3.7, P3.6, P3.5 respectively. The data has to be sent over data bus i.e.P2.

The instruction set given below will be used to initialize the LCD module as required by the application programs.

3.5.4 LCD Instruction Set

INSTRUCTION	CODE									
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Clear display	0	0	0	0	0	0	0	0	0	1
Return home Cursor to 00	0	0	0	0	0	0	0	0	1	X
entry mode set	0	0	0	0	0	0	0	1	1/D	S
display on/off control	0	0	0	0	0	0	1	D	C	B
cursor on/ display shift	0	0	0	0	0	1	S/C	R/L	X	X
function set	0	0	0	0	1	DL	N	F	X	X
read busy flag address	0	1	BF	———	———	———	———	AC	———	———

X = don't care

1/D = 1 increment cursor

1/D = 0 decrement cursor

S/C = 1 display shift

S/C = 0 cursor move

R/L =1 shift to right

R/L = 0 shift to left

B = 1 blink on

B = 0 blink off

AC = address

C = 1 cursor on

C = 0 cursor off

S = 1 display shift when data is written

for normal operation, set to 0

DL = 1 8 bits data length

DL = 0 4 bits data length

N = 1 2 display lines

N = 0 1 line

F = 1 10x5 dots

F = 0 7x5 dots

D = 1 display on

D = 0 display off

BF = 1 LCD Busy

BF = 0 can accept instruction or data

3.6 INTERRUPTS

External Interrupts: The **INT0** and **INT1** interrupts are available to user, these are provided with on-board switches.

Internal Interrupts: On-Chip Timer interrupts are available to user. The ESA MCB 51 monitor program uses the on-chip serial interrupt, so this should not be used in application programs.

3.7 CONNECTOR DETAILS

The ESA MCB 51 comprises of eight different connectors in addition to one 40-Pin connector site.

3.7.1 CONNECTOR DESCRIPTIONS

J5 : Power Connector or Jack

J1 : 10-Pin connector for Port P0

J2 : 10-Pin connector for Port P1

J3 : 10-Pin connector for Port P2

J4 : 10-Pin connector for Port P3

LCD : 15-Pin Flow Strip Connector for LCD

J7 : 26-Pin connector fro Ports P0, P1 and P2.

J6 : RJ11 connector for RS-232C signals.

J8 : 40-Pin connector site for all CPU signals.

3.7.2 CONNECTION DETAILS AND SIGNAL DEFINITIONS

J5: +5 Volts Power Jack

Center - +ve

Outer - Gnd

J1: 10-Pin Male Connector for Port P0

Pin No. on J1	P0
1	P0.0
2	P0.1
3	P0.2
4	P0.3
5	P0.4
6	P0.5
7	P0.6
8	P0.7
9	Vcc
10	Gnd

J2: 10-Pin Male Connector for Port P1

Pin No. on J2	P1
1	P1.0
2	P1.1
3	P1.2
4	P1.3
5	P1.4
6	P1.5
7	P1.6
8	P1.7
9	Vcc
10	Gnd

J1: 10-Pin Male Connector for Port P2

Pin No. on J1	P2
1	P2.0
2	P2.1
3	P2.2
4	P2.3
5	P2.4
6	P2.5
7	P2.6
8	P2.7
9	Vcc
10	Gnd

J2: 10-Pin Male Connector for Port P3

Pin No. on J2	P3
1	P3.0
2	P3.1
3	P3.2
4	P3.3
5	P3.4
6	P3.5
7	P3.6
8	P3.7
9	Vcc
10	Gnd

LCD: 15- Pin Flow strip connector for LCD interface

Pin. No on Connector	LCD Signal	PORTS interfaced
1	Vss (Gnd)	
2	Vdd (Vcc)	
3	Contrast Control	
4	RS (Reg Select)	P3.7
5	R/W* (Read/Write)	P3.6
6	E (Enable)	P3.5
7	DB0	P2.0
8	DB1	P2.1
9	DB2	P2.2
10	DB3	P2.3
11	DB4	P2.4
12	DB5	P2.5
13	DB6	P2.6
14	DB7	P2.7
15	Back Light	Hard wired to Vcc

J7: 26-Pin Male Connector for Ports P0, P1 and P2

Pin No. on J7	PORT Line	Pin No. on J7	PORT Line
1	P2.4	2	P2.5
3	P2.2	4	P2.3
5	P2.0	6	P2.1
7	P1.6	8	P1.7
9	P1.4	10	P1.5
11	P1.2	12	P1.3
13	P1.0	14	P1.1
15	P0.6	16	P0.7
17	P0.4	18	P0.5
19	P0.2	20	P0.3
21	P0.0	22	P0.1
23	P2.6	24	P2.7
25	Vcc	26	Gnd

J6: 6-Pin RJ11 Connector for RS-232C

Pin No. on J6	RS-232C Signals
1	Gnd
2	CRXD
3	CTXD
4	-
5	Gnd
6	-

J8: 40-Pin Connector site for CPU signals

All the 40 CPU signals are available on this connector as it is from CPU.

3.7.3 RS-232C CABLE CONNECTION DETAILS

J6: RJ11 (6-Pin) to 9-Pin D-Type female connector

Pin No. on J6 (RJ11)	Pin No. on 9-Pin D-type
1	1
2	3
3	2
4	-
5	5
6	-

Note: '-' indicates No Connection.

4. ESA MCB 51 MONITOR ROUTINES AND LCD LIBRARY FUNCTIONS

ESA MCB 51 Monitor provides the user with several useful LCD routines that significantly simplifies the task of program development. This chapter gives a list of routines provided by ESA MCB 51 Monitor, which are accessible to the user with their address. Example programs using these routines are given in CD-ROM.

4.1 MONITOR ROUTINES

1. Name of routine: **LCDINIT**
   Function: Initializes the LCD with minimum settings like 5x7 font, No cursor & Blink off, Clear display etc.,
   Call Address: **0E267h**

2. Name of routine: **LCDCMD**
   Function: Writes the Commands to the Instruction register of LCD
   Input: Store the Command byte in accumulator i.e. **A** register.
   Call Address: **0E295h**

3. Name of routine: **LCDDAT**
   Function: Writes the ASCII Characters to the Data register of LCD
   Input: Store the ASCII Character in accumulator i.e. **A** register.
   Call Address: **0E2B4h**

4. Name of routine: **LCDSTATUS**
   Function: Reads the **Busy Flag** of LCD and comes out the routine when **Busy Flag** becomes low.
   Call Address: **0E2D3h**

5. Name of routine: **DELAY**
   Function: Provides **500 μsec** delay, the **R2** register can be used multiply the base delay i.e. to increase the time delay.
   Input: Store the delay multiplier in **R2** register.
   Call Address: **0E2EEh**

6. Name of routine: **CLRLCD**
   Function: Clears the LCD module and brings cursor to home.
   Call Address: **0E2F9h**

7. Name of routine: **HOMECURSOR**
   Function: Brings the LCD Cursor to Home Position.
   Call Address: **0E306h**

8. Name of routine: **SETCURSOR**

Function: This routine sets the LCD cursor type; the Cursor type has to be stored in B (0F0h) register.
B=00h – Selects No Cursor.
B=01h – Selects Normal Cursor.
B=02h – Selects No Cursor & Blink ON
B=03h – Selects Normal Cursor & Blink ON.

Input: Store Cursor type in B (0F0h) register.

Call Address: **0E313h**

9. Name of routine: **SHIFTCURSOR**

Function: Shifts the LCD Cursor to left or right depends on the values stored in B (0F0h) and R0 registers.
B=00h- Shifts the Cursor to Left side
B=01h- Shifts the Cursor to Right side
R0= No.of positions to be shifted.

Call Address: **0E35Ah**

10. Name of routine: **GOTOXY**

Function: Moves the Cursor to X-Line, Y-column.

Input: Store Line number in **B (0F0h)** register and Column number in **R0** register. The On-Board LCD consists of 2 Lines and 16 Columns.
B=00h for Line=1.
B=01h for Line=2.

Call Address: **0E380h**

11. Name of routine: **LCDSTR**

Function: Displays the string pointing by **DPTR** register and the string should be terminated with 00h.

Input: Store the starting address of the string in DPTR register and the string should be stored in **CODE** memory.

Call Address: **0E39Eh**

12. Name of routine: **HEX2ASCII**

Function: This Routine converts the lower nibble of accumulator to ASCII number.

Input: Store the number to be converted in lower nibble of Accumulator **A** register.

Call Address: **0E3B0h**

4.2 LCD LIBRARY FUNCTIONS

User can use this Library to do operations on-board LCD.

The Library files includes **1.LCD.LIB**

2.LCD.H

User has to add this LCD.LIB file to the source group of the Project to include LCD.H in the source code file. 'C' Language Examples are given in the CD-ROM, which includes the LCD library.

The functions available in this library are given below.

1. **void InitLcd()**

   Description : Initializes LCD for minimum settings
   i.e.Func Set-8-bit data, 2lines of display, 5x8 dots, Clear display, Disp on & Normal Cursor & Address of first line.

2. **void LcdCmdWrite(unsigned char)**

   Description : Writes a command to Instruction Register.

   Argument : Command Data.

3. **unsigned char LcdCmdRead()**

   Description : Reads LCD's Instruction Register.

   Return Value: Instruction Register content

4. **void LcdDataWrite(unsigned char)**

   Description : Writes a Value into Display RAM.

   Argument : Character value.

5. **void ClrLcd()**

   Description : Clears the LCD.

6. **void WriteChar(unsigned char)**

   Description : Output a character in current Cursor.

   Argument : Character value.

7. **void WriteString(char *)**

   Description : Output character string in current Cursor.

   Argument : Character string's Pointer.

8. **void BusyWait();**

   Description : Wait & Check LCD to be ready.

9. **void LcdDelay(unsigned int)**

10. **void HomeCursor(void)**

    Description : Brings Cursor to home.

11. **void SetCursorType(unsigned char type);**

    Description : Decide Cursor type.

    Argument : type - Cursor type(INPUT)

    type=0- No Cursor;

    type=1-Normal Cursor;

    type=2-No Cursor, Blink

    type=3-Normal Cursor & Blink

12. **void ShiftCursor(unsigned char dir, unsigned char num)**

    Description : Shift to Left and Right current Cursor.

    Argument : dir - Decide direction to be Shift.(INPUT) dir !=0 -> Right Shift, dir= 0 -> Left Shift.

13. **void GotoXY(unsigned char x, unsigned char y)**

    Description : Move Cursor to X Column, Y Row.

    Argument : x - Column to move(INPUT),

    y - Row to move(INPUT),

Note: LCD used on ESA MCB 51 is '2x16' dimension,

No. of Rows=2, i.e Y=0 or 1.

No. of Columns= 0fh i.e. X=0h to 0fh

ASCII CODES

HEX	DEC	CHAR	HEX	DEC	CHAR
00	0	NUL	22	34	‘’
01	1	SOH	23	35	#
02	2	STX	24	36	$
03	3	ETX	25	37	%
04	4	EOT	26	38	&
05	5	ENQ	27	39	!
06	6	ACK	28	40	(
07	7	BEL	29	41	)
08	8	BS	2A	42	*
09	9	HT	2B	43	+
0A	10	LF	2C	44	‘
0B	11	VT	2D	45	-
0C	12	FF	2E	46	.
0D	13	CR	2F	47	/
0E	14	SO	30	48	0
0F	15	SI	31	49	1
10	16	DLE	32	50	2
11	17	DC1	33	51	3
12	18	DC2	34	52	4
13	19	DC3	35	53	5
14	20	DC4	36	54	6
15	21	NAK	37	55	7
16	22	SYN	38	56	8
17	23	ETB	39	57	9
18	24	CAN	3A	58	:
19	25	EM	3B	59	;
1A	26	SUB	3C	60	<
1B	27	ESC	3D	61	=
1C	28	FS	3E	62	>
1D	29	GS	3F	63	?
1E	30	RS	40	64	@
1F	31	US	41	65	A
20	32	SP	42	66	B
21	33	!	43	67	C

HEX	DEC	CHAR	HEX	DEC	CHAR
44	68	D	62	98	b
45	69	E	63	99	c
46	70	F	64	100	d
47	71	G	65	101	e
48	72	H	66	102	f
49	73	I	67	103	g
4A	74	J	68	104	h
4B	75	K	69	105	I
4C	76	L	6A	106	j
4D	77	M	6B	107	k
4E	78	N	6C	108	l
4F	79	O	6D	109	m
50	80	P	6E	110	n
51	81	Q	6F	111	o
52	82	R	70	112	p
53	83	S	71	113	q
54	84	T	72	114	r
55	85	U	73	115	s
56	86	V	74	116	t
57	87	W	75	117	u
58	88	X	76	118	v
59	89	Y	77	119	w
5A	90	Z	78	120	x
5B	91	[	79	121	y
5C	92	\	7A	122	z
5D	93	]	7B	123	{
5E	94	^	7C	124	I
5F	95	-	7D	125	}
60	96	‘	7E	126	~
61	97	a	7F	127	DEL